

**What is claimed is:**

1. A method for operating a servo system including a first member and a second member that is positionable relative to said first member in response to position  
5 signals, the method comprising the steps of:

generating a position signal to cause said second member to be positioned at a desired location relative to said first member; and

reducing a position error in the position signal  
10 by non-linear attenuation, wherein the position error is due to a disturbance in the servo system.

2. The method of claim 1, wherein:

a disturbance in the servo system generates a  
15 disturbance signal in the position signal; and

the step of reducing the position error further includes the steps of selectively adjusting the disturbance signal as function of the magnitude of the disturbance signal.

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3. The method of claim 2, wherein said function has a first selectable parameter  $N$  representing a threshold level for non-linear signal level adjustment.

4. The method of claim 2, wherein said function has a selectable threshold level  $N$  for signal level adjustment, such that adjusting the disturbance signal is a non-linear function of the ratio of the amplitude of the disturbance  
5 signal and threshold value  $N$ .

5. The method of claim 4, wherein said function further has a second selectable parameter  $M$  representing a signal adjusting factor.

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6. The method of claim 5, wherein said function is a cubic function.

7. The method of claim 6, wherein said function is  
15 represented as:

$$f(u) = M \left( \frac{u}{N} \right)^3,$$

wherein  $u$  represents the disturbance signal input.

20 8. The method of claim 1, wherein:  
a disturbance in the servo system generates a disturbance signal in the position signal; and

the step of reducing the position error further includes the steps of selectively adjusting the disturbance signal as a non-linear function of the magnitude of the disturbance signal, such that attenuation of the  
5 disturbance signal increases as a non-linear function of the magnitude of the disturbance signal.

9. The method of claim 2, wherein said function is an odd function.

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10. The method of claim 1, wherein a disturbance in the servo system generates a disturbance signal in the position signal, and the method further comprising the steps of:

15 filtering the position signal to selectively pass the disturbance signal;

generating a correction signal having a magnitude that varies as a non-linear function of the magnitude of the disturbance signal; and

20 combining the correction signal with the position signal to generate a corrected position signal with a disturbance signal that is adjusted as a non-linear function of the level of the disturbance signal, thereby reducing the position error in the position signal.

11. The method of claim 10, wherein the step of filtering the position signal further comprises the steps of:

determining the frequency band of the disturbance  
5 signal; and

filtering the position signal to selectively pass the disturbance signal.

12. The method of claim 11, wherein the step of  
10 filtering the position signal includes the steps of filtering the position signal using a peak filter based on the frequency band of the disturbance signal.

13. The method of claim 10, further the step of  
15 filtering the position signal includes the steps of:  
determining the frequency band and magnitude range of the disturbance signal; and

filtering the position signal using a peak filter based on the frequency band and magnitude range of the  
20 disturbance signal to selectively pass the disturbance signal.

14. The method of claim 10, wherein the step of generating the correction signal further includes

generating the correction signal such that the magnitude of the correction signal increases as a non-linear function of the magnitude of the disturbance signal.

5           15. A servo system comprising:

          a first member;

          a second member positionable relative to said first member in response to position signals;

          a control loop including:

10                   a servo controller that generates a position signal coupled to said second member to cause said second member to be positioned at a desired location relative to said first member; and

          an attenuator that selectively reduces a  
15 position error in the position signal by non-linear filtering, wherein the position error is due to a disturbance in the servo system.

          16. The servo system of claim 15, wherein the  
20 attenuator includes a gain controller that adjusts a disturbance signal as a non-linear function of the magnitude of the disturbance signal.

17. The servo system of claim 16, wherein said function in the gain controller has a first selectable parameter  $N$  representing a threshold level for non-linear signal level adjustment.

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18. The servo system of claim 16, wherein said function in the gain controller has a selectable threshold level  $N$  for signal adjustment, such that the gain controller adjusts the disturbance signal as a non-linear function of the ratio of the amplitude of the disturbance signal and threshold value  $N$ .

19. The servo system of claim 18, wherein said function in the gain controller further has a second selectable parameter  $M$  representing a signal adjustment factor.

20. The servo system of claim 19, wherein said function in the gain controller is a cubic function.

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21. The servo system of claim 20, wherein said function in the gain controller is represented as:

$$f(u) = M \left( \frac{u}{N} \right)^3,$$

wherein  $u$  represents the amplitude of the disturbance signal.

22. The servo system of claim 15, wherein the gain  
5 controller adjusts a disturbance signal such that reduction of the position error increases as a non-linear function of the magnitude of the disturbance signal.

23. The servo system of claim 16, wherein said  
10 function in the gain controller is an odd function.

24. The servo system of claim 15, wherein the attenuator includes:

a filter that filters the position signal to  
15 selectively pass a disturbance signal;

a gain controller that generates a correction signal having a magnitude that varies as a non-linear function of the magnitude of the disturbance signal; and

a combiner that combines the correction signal  
20 with the position signal to generate a corrected position signal with an adjusted disturbance signal.

25. The servo system of claim 24, wherein the filter comprises a band pass filter.

26. The servo system of claim 24, wherein the filter comprises a peak filter selected based on the frequency band of the disturbance signal.

5        27. The servo system of claim 24, wherein the filter comprises a peak filter selected based on the frequency band and magnitude range of the disturbance signal to selectively pass the disturbance signal.

10       28. The servo system of claim 24, wherein the magnitude of the correction signal increases as a non-linear function of the magnitude of the disturbance signal.

29. The servo system of claim 24, wherein:  
15       the position signal includes multiple peaks at different frequencies; and  
      the attenuator includes:

      a first filter that filters the position  
signal to selectively pass a disturbance signal at a first  
20 peak frequency;

      a first gain controller that generates a  
first correction signal having a magnitude that varies as a  
non-linear function of the magnitude of the said  
disturbance signal at the first peak frequency;



a second filter that filters the position signal to selectively pass a disturbance signal at a second peak frequency;

a second gain controller that generates a  
5 second correction signal having a magnitude that varies as a non-linear function of the magnitude of said disturbance signal at the second peak frequency;

a combiner that combines the first and/or the second correction signals with the position signal to  
10 generate a corrected position signal with adjusted disturbance signals, to thereby reduce position errors in the position signal.

30. The servo system of claim 24, wherein the  
15 attenuator further comprises:

a saturation filter that limits the output of the attenuator to preserve servo-loop stability as the gain controller output increases above a threshold.

20 31. The servo system of claim 24, wherein the attenuator further comprises:

a deadzone controller that filters the output of the attenuator to preserve servo-loop stability as the gain controller output decreases below a threshold.

32. A disk drive comprising:

a disk for storing information content in tracks;

a transducer structure positionable over one of  
said tracks for reading said information content therefrom;

5 a control loop including:

a servo controller that generates a position  
signal coupled to said transducer structure to cause said  
transducer structure to be positioned relative at a desired  
track on the disk; and

10 an attenuator that selectively reduces a  
position error in the position signal by non-linear  
attenuation, wherein the position error is due to a  
disturbance in the disk drive.

15 33. The disk drive of claim 32, wherein the  
attenuator includes a gain controller that adjusts a  
disturbance signal in the position signal as a non-linear  
function of the magnitude of the disturbance signal.

20 34. The disk drive of claim 33, wherein said function  
in the gain controller has a first selectable parameter  $N$   
representing a threshold level for non-linear signal  
adjustment.

35. The disk drive of claim 33, wherein said function  
in the gain controller has a selectable threshold level  $N$   
for signal adjustment, such that the gain controller  
adjusts the disturbance signal as a non-linear function of  
5 the ratio of the amplitude of the disturbance signal and  
threshold value  $N$ .

36. The disk drive of claim 35, wherein said function  
in the gain controller further has a second selectable  
10 parameter  $M$  representing a signal adjustment factor.

37. The disk drive of claim 36, wherein said function  
in the gain controller is a cubic function.

15 38. The disk drive of claim 37, wherein said function  
in the gain controller is represented as:

$$f(u) = M \left( \frac{u}{N} \right)^3,$$

wherein  $u$  represents the amplitude of the  
disturbance signal input.

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39. The disk drive of claim 32, wherein the gain  
controller adjusts the disturbance signal such that

adjustment of the disturbance signal increases as a non-linear function of the magnitude of the disturbance signal.

40. The disk drive of claim 33, wherein said function  
5 in the gain controller is an odd function.

41. The disk drive of claim 32, wherein the attenuator includes:

a filter that filters the position signal to  
10 selectively pass the disturbance signal;

a gain controller that generates a correction signal having a magnitude that varies as a non-linear function of the magnitude of a disturbance signal in the position signal; and

15 a combiner that combines the correction signal with the position signal to generate a corrected position signal with a selectively and non-linearly adjusted disturbance signal.

20 42. The disk drive of claim 41, wherein the filter comprises a band pass filter.

43. The disk drive of claim 41, wherein the filter comprises a peak filter selected based on the frequency band of the disturbance signal.

5        44. The disk drive of claim 41, wherein the filter comprises a peak filter selected based on the frequency band and magnitude range of the disturbance signal to selectively pass the disturbance signal.

10       45. The disk drive of claim 41, wherein the magnitude of the correction signal increases as a non-linear function of the magnitude of the disturbance signal.